CALIFORNIA DIVISION OF MINES AND GEOLOGY

Fault Evaluation Report FER-78

September 19, 1978

1. Name of fault

Brawley fault.

2. Location of fault

The fault lies within the central part of the Imperial Valley, Imperial County, about halfway between the towns of Brawley and Holtville (figure 1).

3. Reason for evaluation

New published data by Sharp (1976 and 1977) indicate that the extent of the fault is greater than that shown by Kahle (1975), whose mapping served as the basis for establishing the existing Special Studies Zone along this fault (California Division of Mines and Geology, 1976). Also, this fault lies within the 1978 study area of the 10-year fault evaluation program.

4. List of references

California Division of Mines and Geology, 1976, Official Map of Special Studies Zones, Alamorlo quadrangle.

Jennings, C.W., 1975, Fault Map of California with locations of volcanoes, thermal springs and thermal wells: California Division of Mines and Geology, California Geologic Data Map Series, Map no. 1. Scale 1:750,000.

Johnson, C.E., and Hadley, D.M., 1976, Tectonic implications of the Brawley earthquake swarm Imperial Valley, California, January 1975: Bulletin of the Seismological Society of America, v. 66, p. 1133-1144.

Johnson, D.A., and Hanks, T.C., 1976, Strong-motion earthquake accelerograms at Brawley, California: January 25, 1975: Bulletin of the Seismological Society of America, v. 66, no. 4, p. 1155-1158.

Kahle, J.E., 1975, Map of part of the Alamorio and Holtville West quadrangles, Imperial Valley, California. Unpublished map, California Division of Mines and Geology.

Real, C.R., Parke, D.L., and Toppozada, T.R., 1977, Magnetic tape catalog of California earthquakes, 1900-1974: California Division of Mines and Geology.

Sharp, R.V., 1976, Surface faulting in Imperial Valley during the earthquake swarm of January-February 1975: Bulletin of the Seismological Society of America, v. 66, no. 4, p. 1145-1154.

Sharp, R.V., 1977, Map showing Holocene surface expression of the Brawley fault, Imperial County, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-838.

Aerial Photography

Designation: Fairchild C-4650 (also USDA no. 13-ABN)

Date: 11/21/37

Type: Black and white, vertical stereo

Scale: 1:20,000

Coverage: All of the Imperial Valley

Availability: Fairchild aerial photography collection, Geology Department, Whittier College, Whittier, California.

5. Summary of available data

The Brawley fault was first recognized as such because of ground rupture that occurred during the earthquake swarm along that fault in January and February of 1975. Kahle (1975) mapped surface ruptures along the fault at that time, and his map was used as the basis for the Special Studies Zone established along that fault (California Division of Mines and Geology, 1976).

Sharp (1976) describes the characteristics of the surface rupture along the fault. Later, Sharp (1977) provides a detailed map of the surface rupture features, along with an interpretive map of the fault made from 1937 aerial photography.

Johnson and Hadley (1976) describe the seismic characteristics of the 1975 earthquake swarm. Johnson and Hanks (1976) describe strong-motion accelerograms made during the swarm.

Another earthquake swarm occurred in the vicinity of the Brawley fault during late October and early November 1977. J.E. Kahle (personal communication) visited the fault in early November 1977, but observed no new ground rupture.

The Brawley fault is expressed at the surface by a zone of en echelon traces. The zone trends nearly north-south, but locally the traces exhibit variations in trend as great as 20° to the east or west (figure 4). Locally, the fault zone has left-stepping traces that are separated from one another by as much as 200 m. The dip of the Brawley fault has not been definitely established based on surface expression (Sharp, 1976, p. 1148). Johnson and Hadley (1976, p. 1141) say, "Both the focal mechanisms and the distribution of hypocenters suggest that the

seismically active portion of the Brawley fault is a vertical plane striking N. 8 W." The "seismically active portion" of the Brawley fault, however, lies mostly to the north of that part of the fault which has been identified by surface features (figure 3).

Prior to the 1975 surface rupturing, the main surface expression of the Brawley fault was a series of continuous or left-stepping en echelon west-facing scarps. Sharp (1977) indicates that many of these are clearly visible on 1937 aerial photography, but that, by 1975, they had been mostly destroyed by intensive agricultural activity in that area. He indicates on his annotated map that the vertical offset along these scarps, all presumed to be of Holocene age, is as great as 3 m. The alluvial strata at the surface in this area are all presumed to be Holocene; none of the workers actually discuss this little detail, but Sharp (1976, p. 1145) makes that implication.

Sharp (1976, p. 1147) found evidence of surface movement along a 10.4 km segment of the Brawley fault after the 1975 earthquake swarm. Most of the observed surface features were "... en echelon overlapping multiple fractures usually only a few meters long and 1/2 to 1 m apart..." The en echelon fractures were left-stepping. Regarding the sense of displacement, he adds, "Displacement on most surface fractures consisted of purely extensional opening between 1 and 10 mm but most commonly less than 5 mm. Although no cracks showed detectable lateral offset, many revealed a slight vertical component of slip, the sense of which was uniformly up on the east side." The left-stepping en echelon nature of the surface rupturing is highly indicative of a right-lateral component of movement along the fault zone. Kahle (1975), however, did observe 7 to 8 cm of

right-lateral offset of a concrete drain which he believes had occurred, possibly in a cumulative manner, between 1968 and 1975.

Historic movement along the Brawley fault has apparently occurred prior to 1975. Sharp (1976, p. 1152) discusses evidence, informally obtained from employees of the Imperial County Road Department, that indicates that displacements occurred at the time of the 1940 Imperial Valley earthquake, and that creep had probably been occurring between 1940 and 1975. Some of the distributive historical displacement is as much as 100 meters wide, based on leveling at Keystone Rd. (Sharp, 1976, fig. #).

Figure 2 shows the distribution of "A" quality earthquake epicenters in the southern Imperial Valley area. Figure 3 shows the epicenters associated with the 1975 earthquake swarm. It is clear that this area is very seismically active, but it is strange that the part of the fault that has shown historic surface rupture lies within an aseismic enclave.

6. Interpretation of aerial photography

I was able to obtain only one set of aerial photo coverage of this fault: Fairchild C-4650 (1937). This is the same photo set as used by Sharp (1977). The Brawley fault is covered by frames 7-7 to 7-17. I see essentially the same features as discussed and mapped by Sharp (1977). I concur with his interpretation of this photo set. I concur with the locations in which he has plotted the features on the 1:24,000 base map (Alamorio and Holtville West quadrangles).

7. Field observations

None.

FEK 78

8. Conclusions

The entire length of the Brawley fault, as it has been delineated by Sharp (1977), is an active Holocene fault. Much of the length of the fault has had surface rupture during historic time. No surface evidence for faulting has been observed to the north of the features mapped by Sharp (1977), even though that area has been very active seismically. Where the fault is evident at the surface, it is not certain whether any of the offset occurred abruptly, rather than by creep. Creep undoubtedly accounts for some of the offset, if not all. Even in 1975 no one was able to show that the observed offsets were caused by sudden movements, rather than by creep over a period of hours, days, or even longer.

9. Recommendations

I recommend that one continuous zone be established along the entire length of the fault as mapped by Sharp (1976 and 1977). This includes some revision of the existing zones along the fault within the Alamorio quadrangle, and new zoning along the fault within the Holtville West Quadrangle. Figure 4 shows the zone that I recommend and the depiction of the fault that I recommend for the SSZ maps. I do not recommend field or additional photo studies.

10. Investigating geologist's name; date:

Drew P. Smith

DREW P. SMITH
Geologist
September 19, 1978

I concur with the recommendation to zone approx. as indicated on fig. 4. Please check accuracy of fault locations and evidence for additional creep along hwy roads & canals, if time permits (10-20 days).
Elliott
10/12/78

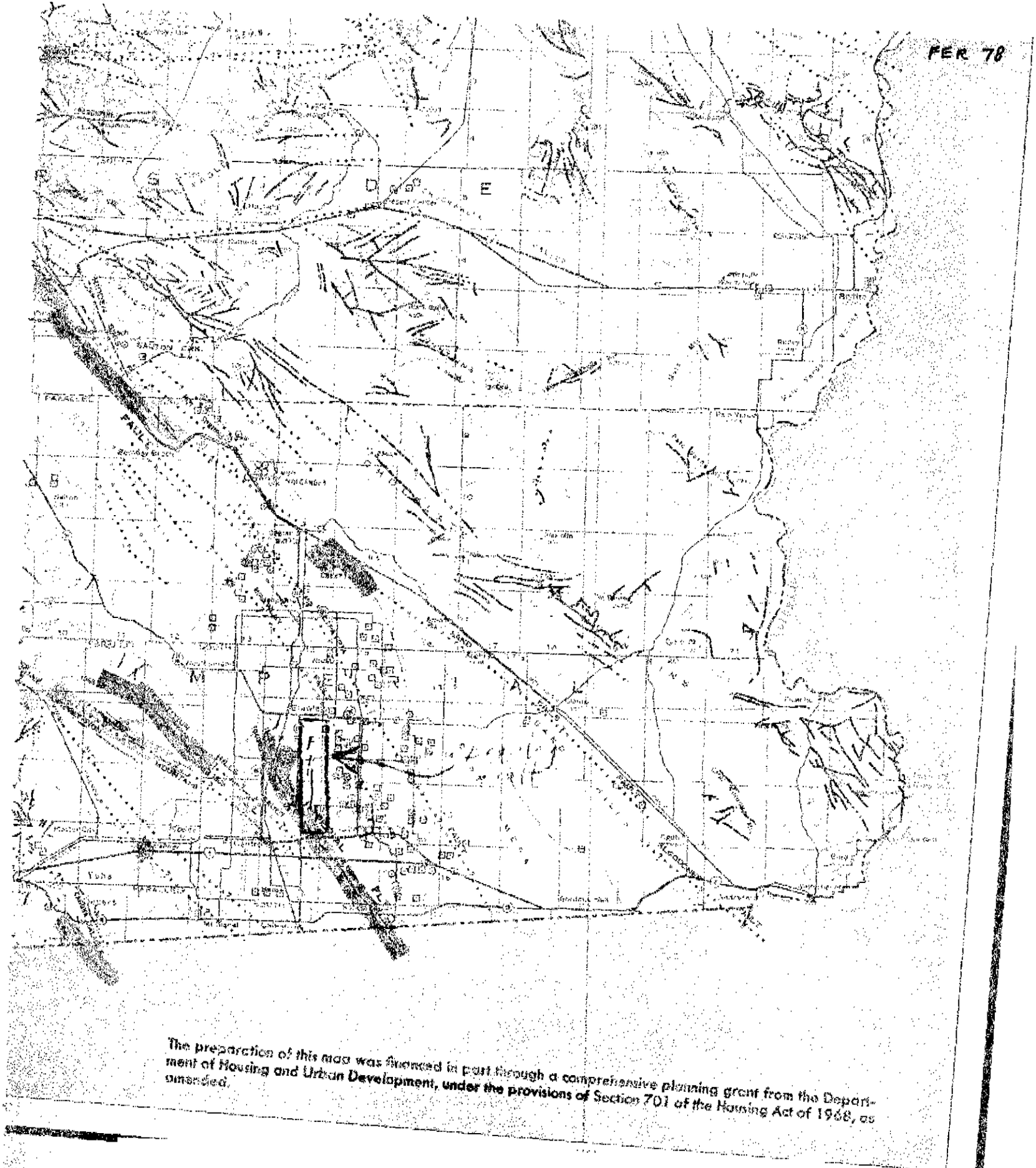


Figure 1. Index map showing the location of the Brawley fault. Map is modified from Jennings (1975).

FER 78 Figure 2 FER-78

EARTHQUAKE EPICENTERS 1900-1974: SAN DIEGO-EL CENTRO SHEET

EQUAL TO OR GREATER THAN MAGNITUDE 3.0 OR INTENSITY V

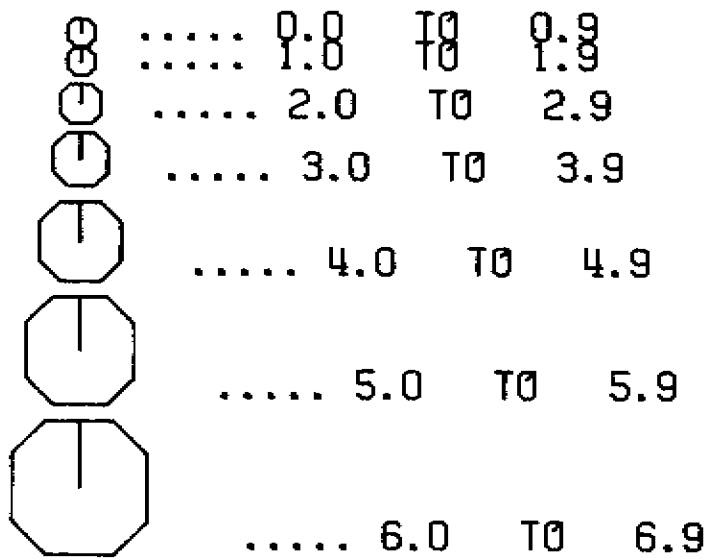
EARTHQUAKE CATALOG EDITION I

CALIFORNIA DIVISION OF MINES AND GEOLOGY

TRANSVERSE MERCATOR PROJECTION

SCALE = 1/250000

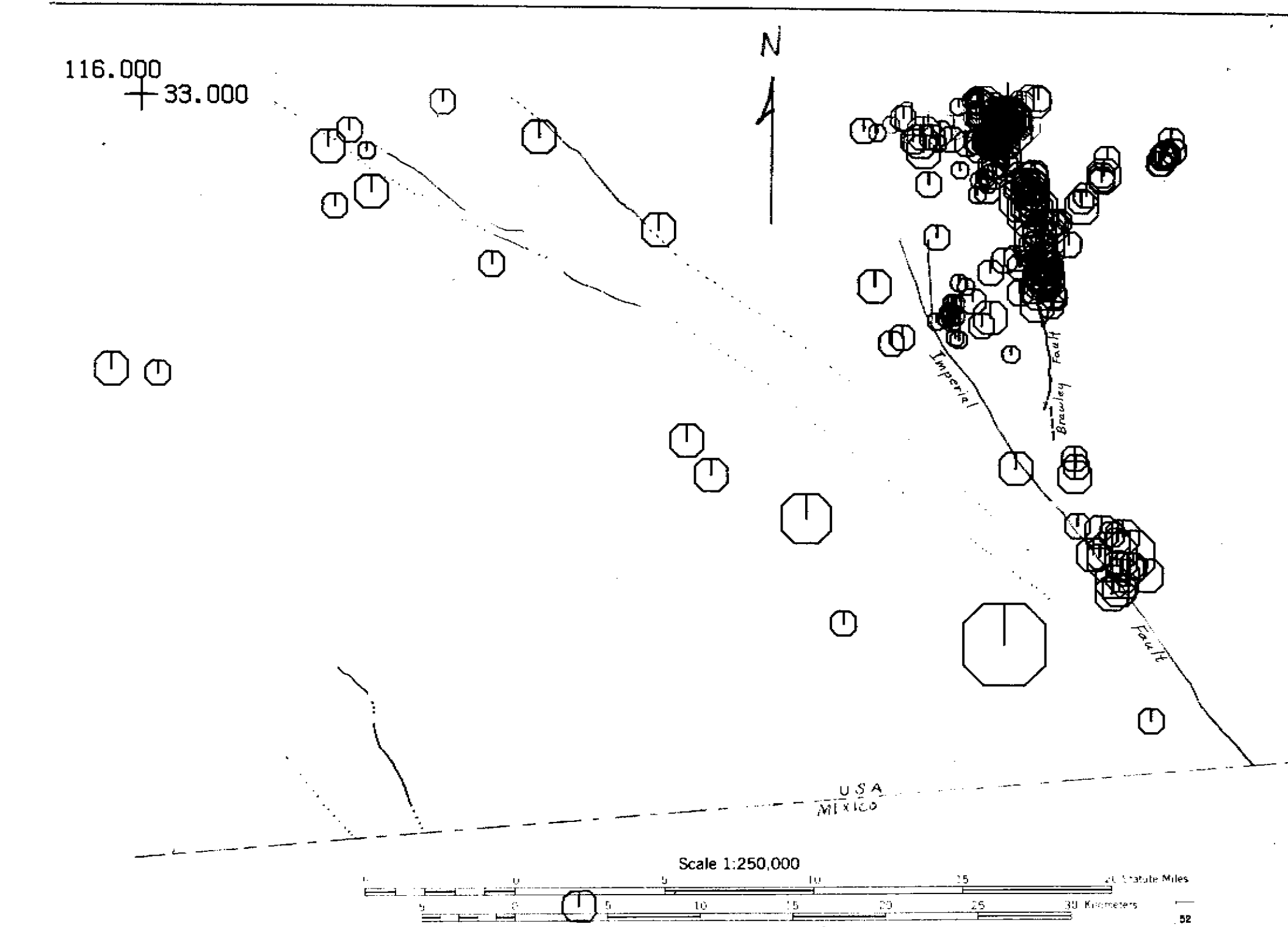
MAGNITUDE



"A" quality data

(DATA SOURCES ARE: FOR 1900-1931, CDMG SPECIAL REPORT 135; FOR 1932-1974, CALTECH AND U.C.BERKELEY FOR SOUTHERN AND NORTHERN CALIFORNIA RESPECTIVELY; AND SINCE 1969, THE USGS FOR CENTRAL CALIFORNIA. A COMPREHENSIVE CATALOG OF CALIFORNIA EARTHQUAKES IS AVAILABLE ON MAGNETIC TAPE AND MICROFICHE FROM CDMG.)

FER 78 FIG. 2 cont'd



FER-78

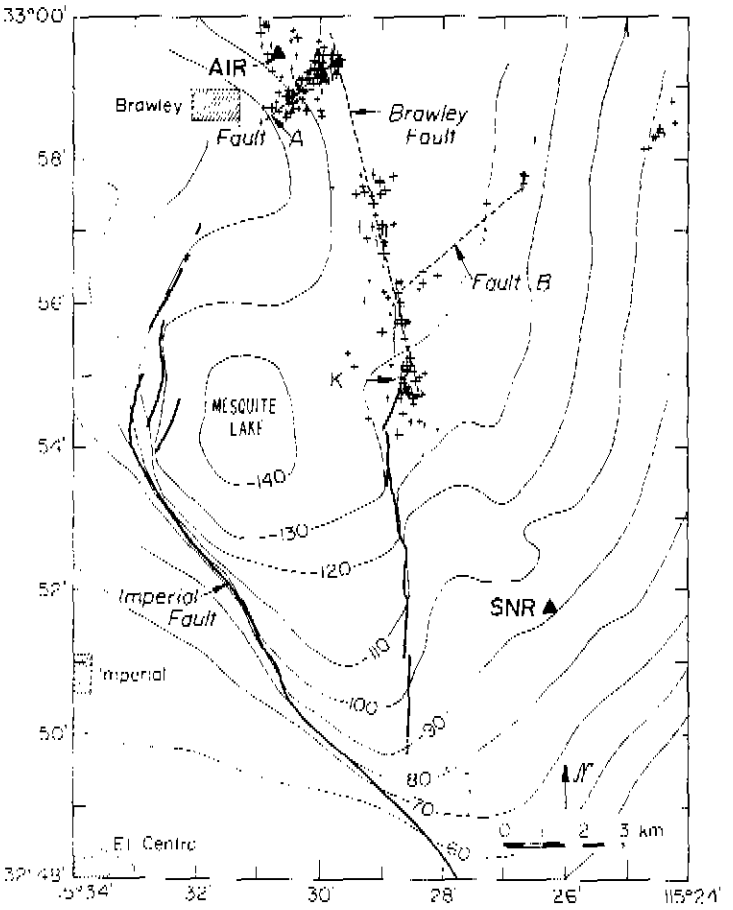


FIG. 2. Detailed map showing epicenters associated with the Brawley swarm (plus signs, size proportional to magnitude), observed surface faulting (heavy lines), faults inferred from seismicity (dashed lines), and topographic contours (light lines). The letter "K" indicates the point where the surface faulting coincident with the Brawley swarm crossed Keystone Road.

Figure 3. A reproduction of figure 2 of Johnson and Hadley (1976, p. 1138).